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ABSTRACT

Opening with a discussion of AARON, an artificial intelligence symbol system that is used to generate computer drawings, this document makes the argument that AARON is based upon a way of knowing that is abstract, analytical, rationalist and thus representative of the dominant, western, male philosophical tradition. Male bias permeates the field of computer science. The implications for females in the field, particularly those who use the computer for their art making and in the teaching of art making, is explored. Questions are posed about how the nature of computer science, and in particular its relationship to art making and art education, might be otherwise than one driven by the idea of masculinity and a male way of knowing. An alternative way of knowing that may be employed in computer technology emphasizes negotiating and renegotiating with well know materials (a process sometimes called "bricolage"), and using the computer to "make connections." Such an approach contrasts with the analytical, hierarchical approach of AARON. There is a need to give consideration to a multiplicity of ways of knowing in the use of the computer for art making and for art education. A 34-item list of references is included. (DB)

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IMPLICATIONS OF GENDERED TECHNOLOGY FOR ART EDUCATION: THE CASE STUDY OF A MALE DRAWING MACHINE

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In 1985 Evelyn Keller (1985, p. 3) asked the question: "how much of the nature of science is bound up with the idea of masculinity, and what would it mean if it were otherwise?" Following Keller's lead, I pose the same question to the field of computer science. I will proceed by investigating, through a case study of the drawing program AARON, the strong artificial intelligence symbol system position in computer science that represents a male way of knowing. Artificially intelligent AARON, the creation of renowned modern artist Harold Cohen, has been producing computer generated drawings for almost two decades. Cohen moved from canvas painting to the computer in 1968 when canvas painting failed to satisfy his artistic exploration concerning the cognitive formation of visual structure and how this yields meaning to the viewer.

I will argue, first, that AARON represents a male, western, analytic way of knowing. Second, I will address the larger issue of male domination in the field of computer science connected to this male way of knowing and discuss how this effects the use of the computer in art making and in art education. Finally, I suggest ways of how this might be otherwise by pointing to other ways of knowing.

AARON's Way of Knowing

Aaron, one of the few successful examples of artificial intelligence in the visual arts, generates plotter drawings. His imagery of the 1970s focused upon abstract geometric line drawings (Figures 1 and 2) and, in the mid-1980s, his programmed knowledge base was expanded to include knowledge of humans and plant morphology,

resulting in "freehand" type drawings of people located in garden like settings (Figures 3 and 4). AARON's current imagery centers on interior spaces sparsely populated with plants and female figures (Figures 5 and 6).

Although AARON is an expert system, Cohen designates AARON as an expert's system. In making this distinction Cohen points out that the AARON program was developed by experts, not to capture their knowledge for use by others, but with the objective of increasing their own expertise, thus enhancing their own creativity rather than attempting to increase their productivity (Cohen, 1988). This differs somewhat from the principle of expert systems, a subset of artificial intelligence in which an expert's knowledge base is captured in a computer program and made available to non-experts. Cohen's art making system varies also from the more orthodox expert systems regarding motivation. There exists a symbiotic interdependence between the program and Cohen's understanding that drives it, and this brings about an increasing understanding of art making in the AARON program. (Cohen, 1987). AARON is a hierarchial, rule-based, knowledge based program incorporating knowledge of how to draw, and what it is drawing, for example, plants, trees, rocks, and human figures. Cohen explains: "the object specific knowledge is used by AARON to construct, in 'imagination,' a core figure that it then 'fleshes-out' into the drawing as the viewer sees it" (Cohen, 1987, 9) (Figure 7).

Cohen's AARON project meshes with the strong artificial intelligence physical symbol system viewpoint of psychologist Herbert Simon and computer scientist Allen Newell. Strong artificial intelligence regards the appropriately programmed computer

as a mind possessing cognitive states, in contrast to a weak viewpoint that deems the computer program more simply as a powerful tool in relation to the study of mind (Searle, 1980). This way of looking at digital computers has become a way to look at minds. Newell and Simon hypothesized that the brain and the digital computer, although differing in structure and mechanism, held in common a functional description at a certain abstract level (Dreyfus and Dreyfus, 1988). At this level both the brain and the digital computer can be viewed as two instances of a particular device--a device that generates intelligent behaviours through the manipulation of symbols by means of formal rules (Dreyfus and Dreyfus, 1988). The Simon-Newell position, and by extension Cohen and AARON, trace their lineage to the long, atomistic, rationalist tradition of western philosophy embodying the viewpoints of Descartes, Hobbes, Leibniz, Frege, Russell and Whitehead. For example, Leibniz, working out of the classical concept of mathesis, that is the formalization of everything, attempted to develop a universal symbol system that assigns to every object a determined and characteristic number (Dreyfus and Dreyfus, 1988). AARON's rules (number and symbol formulations) are steps of reasoning and the specific subject matter of a specific rule is broken up into atoms, for example, the drawing of an arm. AARON is based upon and continues the assumptions of the atomistic, rationalist tradition and way of knowing.

Feminist critique, such as that mounted by Evelyn Keller (1985), Sandra Harding (1986, 1991), Carol Gilligan (1982), and Sherry Turkle (1990), among others, takes issue with this position which they label as a dominant, western, male philosophical tradition that gives shape to an analytic way of knowing, and they seek out alternative

understandings of mind. Keller points out that science is a socially constructed category and focuses upon how the shaping of men and women has influenced the making of science. She criticizes the deeply rooted popular mythology of the natural sciences that holds "objectivity, reason, and mind as male, and subjectivity, feeling, and nature as female" (Keller, 1985, p. 6-7). Thus, there exists a division of labour. Women have been the protectors of the personal and emotional whereas men have been guarantors of the impersonal and the rational, and this split has brought about a deeper separation of feminine and masculine, subjective and objective, and love and power, components of our humanness that affect all of us (Keller, 1985). This division has lead to the fact that modern science has been produced by one particular subset of the human race -- almost entirely by white, middle class males -- and this evolved from an ideal of masculinity distinguished by its virile power, and its capacity to use nature in man's service and as his slave (Keller, 1985). Further, this separation has led to the autonomy of science that mostly disregards the social study of science and affirms the divisions of public and private, impersonal and personal, and masculine and feminine.

Turkle and Seymour Papert in their discussion of noncanonical approaches to science and technology, looking to ways of knowing that go beyond the limiting constructs of science, build on Keller's and Carol Gilligan's arguments that question the idea of a single, privileged way of knowing that is western and male, and they assert that key issues in a critique of science are not about scientific reasoning but about reasoning in general (Turkle and Papert, 1990). They contend that the formal, propositional way of knowing has been the traditional, canonical standard, and that

philosophical epistemology has generally equated it with knowledge (Turkle and Papert, 1990). This results in the difficulty that women perceive they must develop an approach to knowing that is formal and abstract in order to compete in the academy. Turkle and Papert point out further that other approaches to knowledge have been viewed as inferior and demonstrate in recent studies how different approaches to knowledge are valid on their own terms. They acknowledge Piaget's recognition of ways of knowing in small children that do not conform to the canon, for example, an emphasis on the concrete rather than the abstract, and Levi-Strauss' finding that primitive societies function in a concrete rather than an abstract way of knowing (Turkle and Papert, 1990). These examples support possibilities for concrete, contextual reasoning that give other approaches to knowing beyond analytical reasoning in a broad variety of disciplines.

Thus, the argumentation of Keller, Gilligan, and Turkle and Papert lead us to conclude that AARON is an exemplar of the male, western, analytic way of knowing. He embodies the Newell-Simon approach to artificial intelligence that belongs to canonical approaches to science and philosophy (Cohen 1979, 1987, 1988, 1988a, 1990, 1991) that depict a single and privileged way of thinking. Cohen, in his discussion of the AARON program, also represents a western, male, privileged view of art (Cohen 1988, Morbey 1992). It can be noted, however, that Cohen's writings of the last few years express some disillusionment with the possibilities of the physical symbol system approach and voices an openness to other approaches to artificial intelligence that might better facilitate his objectives for his computer artist AARON (Cohen 1990, 1992). In addition to Cohen's growing awareness are strong critiques concerning the symbol

system approach and its potential, or perhaps limited potential, to simulate what human beings do (Dennett, 1986; Dreyfus and Dreyfus, 1988; Fodor, 1985; Hofstadler, 1985; Johnson-Laird, 1983; Lakoff, 1987). The symbol system strategy limits the parameters of Cohen's exploration to an analytical, logical approach that continues to divide the objective and the subjective, the abstract from the concrete, and logical algorithmic formulations in computation from more subjective, negotiative strategies of computation. Although Cohen has stated an interest in other approaches in artificial intelligence for the solving of his art making problems with artist AARON, and in particular to have AARON more closely assimilate his own art making practices, his intention for AARON to function as an artificially intelligent, autonomous art maker confines him to the male, western concerns in modern science and to its particular approach to knowing.

The Male Domain of Computer Science

From within the broader computer science community comes the accusation that men mainly inhabit the world of computers (Huff and Cooper, 1987). The AARON program illustrates the working of a male viewpoint in a particular subgrouping of artificial intelligence, however, studies indicate that male bias and a male, analytical way of knowing pervades the entire discipline of computer science. Thus, my second objective is to investigate the more broadly perceived male coloration and observe its affect on females who use the computer for art making and in art education.

Studies indicate that one of the root problems of sex bias in the development of software are the expectations and stereotypes of the designers. Educational software is presented in a manner that motivates and excites boys, and at the same time discourages girls. An investigation into how this comes about indicates that when designers are requested to write programs for school children the result is usually action-oriented games for boys (Huff and Cooper, 1987). This level of design geared for elementary school children illustrates the same male viewpoint represented on a more sophisticated level in program AARON. In addition, recent studies substantiate a correlation between educational computing and the western male view of the individual, with the many books and journals published in the area affirming the male viewpoint. Intelligence is viewed by many computer experts as individualistic in nature with procedural thinking seen as the highest level of expression, thus affirming a privileged masculine way of thinking over a feminine way of knowing (Bowers, 1988).

What does this mean for the female who wishes to be professionally involved in the field of computer science? Gender related studies in the field indicate that females experience cumulative disadvantages from the primary levels of schooling through graduate school and beyond (Frenkel, 1990). In 1988 women made up only 10% of those employed as doctoral level computer scientists (Pearl, Pollack, Riskin, Thomas, Wolf, and Wu, 1990). In June of 1990 a workshop was held at the National Educational Computing Conference to examine the assumption that the decline of women choosing computer science as a major can be attributed to a male-oriented paradigm in the field. A group of twelve scholars presented findings, ranging from statistical reports to information

gleaned from personal interviews, in the session "In Search of Gender-Free Paradigms for Computer Science Education," and this data substantiated the conference premise that the discipline of computer science is a male domain (Frenkel, 1990), further supporting the distinctions and divisions delineated in the criticisms of Keller, Gilligan, and Turkle and Papert.

This emphasis on a male way of knowing in the field of computer science, manifest in deeper philosophical critiques and noticeable in everyday practice, holds specific difficulties for those females who use the computer for their art making and in the teaching of art making. The female faces the double obstacle of adapting to a male way of thinking not only in the domain of computer science but also in the male, western domains of art making and art history. Linda Nochlin began the critique of male, western art making and art history in her 1971 article "Why Have There Been No Great Women Artists?" and over the last two decades a substantial body of criticism, mainly from the viewpoint of feminist scholarship, has expanded and deepened discussion concerning the gender question in the visual arts (Nochlin, 1971; Frueh and Raven, 1991; Gouma-Peterson and Mathews, 1987; Robinson, 1988; and Tickner, 1988). In worlds where AARON reigns as king, the female art maker has few choices as already noted by Keller, Gilligan, and Turkle and Papert. Thus far historically, the female computer art maker has accommodated herself to the male viewpoint, using available software, hardware, and computer programmers. This, however, is beginning to change. Joan Stavley, of The Ohio State University's Advanced Computing Center for the Arts and Design, is keenly aware of the male viewpoint of computer science as well

as what she observes as a male dominance in the area of Modern art. She works collaboratively with a computer programmer and has gained international recognition for her work, winning the Golden NICA Award for animation at the "Prix Arts ELECTRONICA 89" in Linz, Austria for her computer animation "Broken Heart." Stavley is interested in more diverse approaches to programming for her work and for teaching about art making on the computer.

Other Voices

Finally, I pose the question of how might the nature of computer science, and in particular its relationship to art making and art education, be otherwise than one driven by the idea of masculinity and a male way of knowing? The title of Gilligan's book *In a Different Voice* implies that their are other approaches to reasoning than the western male model. Levi-Strauss' idea of bricolage offers a differing access to reasoning and subsequently for computer programming (Turkle and Papert, 1990). Levi-Strauss, in his study of primitive cultures, used the term 'bricolage' to contrast the analytic methodology of Western science with what he labelled a 'science of the concrete' in primitive societies (Levi-Strauss, 1968). Bricoleurs (those who employ bricolage) construct theories by arranging and rearranging, by negotiating and renegotiating with a set of well-known materials, not moving abstractly and in a hierarchical manner. Thus, Levi-Strauss, in his observations of persons from a non-western culture describes another approach to knowing that further suggests a variety of ways of knowing that

can be employed in the interdisciplinary cross of art making and the teaching of art making on the computer. The bricolage approach provides what Warren McCulloch called 'heterarchical,' a computer strategy that allows for negotiation, rather than the primary rule-based planning of the hierarchical scheme (McCullock, 1988). The AARON program facilitates knowledge through a hierarchical, rule-based, abstract approach, but, it does not address, nor take into account, other approaches to the acquisition of knowledge (Morbey, 1992).

Stavley, and colleague Carol Gigliotti, both art makers and art educators using computer technology, endorse a bricolage approach in their art making and art teaching. Having spent recent years working in arts and computing environments, they observe that they have had to work against two forces, a male view of Modern art based on continual innovation and a male viewpoint of the computer community that is also concerned with innovation. Their interests differ from the propagation of these approaches. Both claim that their concern lies in using the computer to make connections in their work, rather than towards a primary focus on innovation, and further, they suggest that in postmodernism the issue is not innovation, but in making connections. Feminist theory in postmodern thinking substantiates this viewpoint, apparent in the writings of Gilligan and Turkle.

Gigliotti's current interactive, multi-media work "The Sadness of Dogs" is created through the use of object-oriented programming and authoring systems. There exists a continual interactive connection between the artist and the program as well as the viewer, and the viewer along with the artist is required to participate in the authoring

of the system and in building the meaning of the work. The programming, therefore, offers interactive possibilities not only to the artist but also to any viewer-participant in the work. Knowledge becomes a common ground for a working relationship between artist, software, participant(s) and the varied contexts of the three. Thus, a communal environment incorporating difference is encouraged rather than a sole emphasis on the Modernist competition of innovative difference. This type of software enables the artist or student to arrange and rearrange, to navigate and to re-navigate, to work out a conversation with the program and other participants in the development of imagery rather than to follow a prearranged plan. The bricolage approach gives place for intuition, and enables artists to consider their interaction with the software in a similar way that they do with paint on canvas. It also negates the stereotypical differences that have been suggested to separate the worlds of computing and art making: the artist's sensitive, perceptive, alogical qualities held in comparison to the programmer's logical, inhibited, methodological ritualistic attributes. Through this approach artists, and students learning about art making, are not directed by the structural design of a rule-based, hierarchical system but have the possibility through a more interactive system of letting the effects they are after emerge. This contrasts sharply to a more analytic planned approach that requires a knowledge of how the program works before interacting with it. Thus, artists, teachers, and student art makers are provided alternative choices in their art making on the computer.

In the realm of artificial intelligence there has been a shift away from the dominance in the 1970s and early 1980s of the rule-based expert system approach

evidenced in drawing program AARON. Emergent AI, or new connectionism, for example, sets up a series of independent elements and through the interaction of the elements in the computer intelligence emerges (Turkle and Papert, 1990). The focus is negotiation rather than a logical, formal method. Seymour Papert has suggested that as AI matures, and embodies a diversity of possibilities rather than a specific view, that conceptual frameworks will be developed that enable us to understand more about different ways of knowing (Papert, 1988). This advancement in artificial intelligence would undoubtedly benefit the art maker, and the art teacher, and give place to differing ways of knowing with regard to art making on the computer.

The example of the rule based AARON program as a representative of the male, western, analytic way of knowing dominant in our contemporary computer culture has led to a consideration of other possibilities. Although this paper has argued for the place of other voices, and computer approaches, basing its argumentation on the work of mainly feminist scholars, the point has been not to provide a female polarity to the male viewpoint. Rather, my objective is to move beyond the contemporary gender discourse of the binary polarities to give consideration to a multiplicity of ways of knowing in the use of the computer for art making and for art education. An analytic, logical, hierarchical way of knowing incorporates both male and female thinkers, just as an bricolage approach includes thinkers of both sexes. An investigation of other ways of knowing that moves beyond gender specification and stereotyping looks to possibilities that allow for individual learners, for example, learning about art making on the computer, to experiment in relation to ways that they learn best. This emphasis

parallels contemporary concerns in artificial intelligence that focus on a plurality of approaches for continuing developments in artificial intelligence. A pluralism in ways of knowing then not only crosses genders and intelligences but also technologies, and more importantly, cultures.

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LIST OF FIGURES

1. Harold Cohen, *Untitled*, computer generated drawing, acrylic on plaster, hand painted, 14′ x 110′, 1979, San Francisco Museum of Art.

2. Harold Cohen, *Untitled*, computer generated drawing, acrylic on cotton, hand painted, 14′ x 60′, 1983, Tate Gallery, London.

3. Harold Cohen, *Untitled*, computer generated drawing, india ink on paper, 22" x 30", 1986.

4. Harold Cohen, *Untitled*, computer generated drawing, acrylic on canvas, 108" x 156", 1987.

5. Harold Cohen, *Untitled*, computer generated drawing, oil on canvas, 63" x 90", 1991.

6. Harold Cohen, *Untitled*, computer generated drawing, oil on canvas, 20" x 25", 1991.

7. AARON computer generated plotter drawing in progress.